

NOTES ON THE HABITS OF *PLUSIOTIS GLORIOSA* LE CONTE (Scarabaeidae)¹

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The species of *Plusiotis* which now occur in the southwestern United States are obviously relicts of the rich Central American beetle fauna which must have invaded the now arid region repeatedly during the more favorable periods of the Pleistocene. With the gradual increase in aridity, during or at the end of the ice ages, many tropical forms must have died out or withdrew to the south. The survivors are the remnants which were able to adapt to more arid conditions or to survive the lower temperatures at high elevations in the mountains.

The U. S. species of *Plusiotis* are especially interesting because of their sharp segregation on different food plants. This diversification of larval and adult food habits probably preceded the isolation of the group in the western mountains, and in part explains the restriction of the species to definite zones on the mountains where they occur. For example, in the Huachuca Mountains of Arizona, three of the four known U. S. species occur in a small area. They are not indiscriminately mixed, however, because *P. lecontei* Horn feeds on pine at higher elevations while *P. beyeri* Skinner and *P. gloriosa* LeConte are restricted to oaks and junipers respectively at lower levels (see Cazier, 1951). During the summer of 1956, I had the opportunity of collecting and observing these interesting insects while working at the Southwestern Research Station of the American Museum of Natural History near Portal, Arizona.

My interest in *P. gloriosa* was aroused by the apparent contradiction between its brilliant green and silver coloration and current theories regarding insect coloration. Pinned against almost any background except fresh juniper leaves, this beetle is one of the most conspicuous insects imaginable. It is tempting to hypothesize that the colors are aposematic, a warning to would be predators of a dangerous nature or distastefulness; but, in fact, wing cases are found on the ground so frequently that one must assume that bats and perhaps birds are frequent predators. Mutilated specimens, obviously damaged by some predator, have also been found. The greater part of this predation must occur

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during the twilight period when the beetles are flying silhouetted against the sky, at which time no color would be effective either as a warning or for concealment.

After a few evenings of hunting *Plusiotis* with a headlight through the juniper groves of Cave Creek Canyon in the Chiricahua Mountains, I began to wonder if the colors were not actually concealing. They are certainly so when one searches with a light at night among the juniper leaves for not only does the green color match the background, but the disruptive silver stripes reflect the light in exactly the same manner as the little drops and streaks of resin on the leaves and branches.

The hypothesis of cryptic coloration, however, immediately hits an apparent snag. Most records of *Plusiotis* are of specimens attracted to light or caught at night feeding on juniper. If the species is strictly crepuscular and nocturnal concealing colors are quite useless no matter how well they may match the background, since no animals except man and perhaps some fishes of the abyssal ocean hunt with headlights. The former is too recent an intruder to have influenced the evolution of *Plusiotis*, and the latter are not very well adapted for hunting in juniper groves 4,000 to 6,000 feet above sea level.

But is *P. gloriosa* strictly crepuscular and nocturnal? Devices for the control of temperature, light, and humidity were not available, and this question cannot be answered positively by our observations in 1956; but there are indications that it is humidity and not light which influences the aboveground activities. The relative humidity generally rises with the drop in temperature in the evening in such dry regions as the southwest, and coincidentally the feeding and other activities of the adult beetles in large part correspond to the periods of darkness. If humidity conditions are suitable, however, the beetles remain aboveground throughout the day, and are thus exposed to conditions under which concealing coloration would be of importance. The following observations form the basis for this conclusion:

In 1956, the first *P. gloriosa* found at the Station was dug out of the soil in a grassy area about 50 feet from a large juniper tree on June 21. No significant amount of rain had fallen in the area for some time previous to this date. No others were found until June 27 when following a trace of rain in the afternoon one *gloriosa* came to light. On June 28, 0.42 inches of rain fell, but search on junipers that evening was negative and no *Plusiotis* came to light. On the evening of June 29, following a trace of rain, beetles were found on junipers although the temperature was 70°C. They were feeding 6 to 12' above the ground and clung so tightly to the leaves that they had to be beaten off. Later

in the summer it was noted that at higher temperatures they dropped off and flew very readily.

On June 30, a series of observations on the crepuscular activities of *P. gloriosa* was begun. A watch was kept for flying beetles from shortly after sunset until dark for several evenings. On June 30, after 0.02 inches of rain had fallen, the first *Plusiotis* was seen flying at 8:05 P.M. (Rocky Mountain Standard Time). Four others were seen before 8:40 after which no more were observed. The following evening the first beetle was seen at 7:57 P.M. and the last at 8:26, after which no more were seen flying but several were found on juniper. No further rain fell for several days, and no further flights of beetles were observed on three other evenings in early July, nor were any seen flying later in July. Individuals continued to come to light, however, and a number were found on juniper up until late July.

One of the beetles captured on June 30 was marked with a piece of colored thread and placed on juniper. Next day it was in the same position, and apparently had not moved. That evening it was still in the same place and was mistakenly tied down. On July 2, only the pronotum and the thread remained. When ensconced among the juniper leaves in the daytime, *P. gloriosa* is practically invisible unless it moves. None could be found on vegetation near the Station during the day, but Dr. Minter J. Westfall reported one found at 8:00 A.M., July 19, on juniper in the Galiuro Mountains. This was after a very heavy rain during the preceding night, and many other usually nocturnal beetles were still active in the area.

From July 18 to August 7, a series of observations was made on several *P. gloriosa* males and females in large jars with sand on the bottom and branches of juniper. The correlation of the aboveground activities with humidity was evident, even though exact records of the changes could not be made. The beetles were checked each day between 8:30 A.M. and 5:00 P.M. From July 18 to July 22, about half the beetles were observed at least once each day up in the juniper foliage while the others were burrowed into the sand or on its surface. On July 22, torrential rains fell. Next day 3 of 4 beetles were in the foliage all day, and on the following 3 days all four were in the foliage all day. On the 9th and 10th days two were up and two burrowed into the soil, while on the 11th day all four were in the sand or on its surface. On the 12th day, one of the females was dead, and the cages were then moistened heavily. During the next seven days, up until August 7, the beetles stayed in the foliage all day with one exception on August 3 when a female was found burrowed into the sand. Thus on 11 of the

20 days of observation all beetles were up in the foliage all day, part were up and part down on eight days, and all were down on only one day.

On August 3, three of the *P. gloriosa* were taken out into the sunlight to photograph. One of the males dropped from the juniper branch and took flight. It was last seen about 100 feet in the air headed toward Mexico. The remaining pair were quickly restrained from following.

To repeat, I conclude from these observations that adult *P. gloriosa* spend a considerable part of their time resting and feeding aboveground in the foliage of the junipers provided the humidity is high enough. The restriction of the aboveground activities to the twilight and night are probably more apparent than real in wet seasons due to the difficulty of finding the beetles among the juniper foliage in the daytime. If this is so, the brilliant green and silver coloration is camouflage combining color resemblance to the background and disruptive coloration and not merely a coincidence.

Many tropical rutelids are diurnal. In southern Florida, *Rutela formosa* (Burmeister), for example, feeds openly during the day on the blossoms of the royal poincianas during the wetter months and rests among them at night. It thus seems probable that the behavior of the tropical species of *Plusiotis* is similar to that of *gloriosa*. That is, they move up into the trees to feed under favorable humidity conditions without particular regard to light, and their brilliant colors may have resulted from natural selection rather than accident.

REFERENCES

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